**Code and Name:**

**MAT5780 Applied Functional Analysis**

**Unit:**

Institute of Science, Department of Mathematics

**Details:**

* **Term:** 2023-2024 Spring
* **Status:** Elective
* **Class Level:** 1
* **Credit Hours:** 3-0-0-3
* **ECTS:** 6
* **Language:** Turkish

**Course Instructors:**

* **Course Coordinator:** ...
* **Assistant Instructor:** ...
  + **Phone:** ...
  + **Email:** ...@firat.edu.tr
  + **Social Accounts:** ...

**Weekly Schedule**

| **Monday** | **Tuesday** | **Wednesday** | **Thursday** | **Friday** | **Saturday** |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |

**Teaching Method:**  
Each weekly hour will include at least 45 minutes of face-to-face teaching.

**Location:**

* **In-person (YY):** Classroom (To be announced)
* **Remote (UE):** -

**Objective:**

To teach fundamental topics in functional analysis that form the basis for its applications in mathematical physics and other fields.

**Materials:**

1. Eberhard Zeidler, *Applied Functional Analysis: Applications to Mathematical Physics*
2. D.H. Griffel, *Applied Functional Analysis*
3. J. Tinsley Oden, Leszek Demkowicz, *Applied Functional Analysis*
4. Jean-Pierre Aubin, *Applied Functional Analysis*

**Student Responsibilities:**

Students are required to attend at least 70% of the classes.

**Weekly Lesson Plan:**

| **Week** | **Topic** | **Methodology** |
| --- | --- | --- |
| 1 | Linear spaces, dimensions, normed spaces, and Banach space properties | Face-to-Face |
| 2 | Banach spaces and fixed-point theorems: Banach fixed-point theorem, iteration method, applications to integral equations | Face-to-Face |
| 3 | Banach spaces: Continuity, convexity, compactness, finite-dimensional Banach spaces, equivalent norms, Minkowski functional, and homeomorphism | Face-to-Face |
| 4 | Brouwer and Schauder fixed-point theorems, Leray-Schauder principle | Face-to-Face |
| 5 | Normed spaces: Series, Banach algebras, operator functions, applications to linear differential equations | Face-to-Face |
| 6 | Applications of Banach algebras to linear differential equations | Face-to-Face |
| 7 | Banach spaces: Spectrum applications, density, and approximation | Face-to-Face |
| 8 | Hilbert spaces: Orthogonality, Dirichlet principle, bilinear forms, variational problems, and Riesz method | Face-to-Face |
| 9 | **Midterm Exam** | Face-to-Face |
| 10 | Hilbert spaces: Linear functionals, Riesz theorem, duality, variational problem duality, nonlinear monotone operators | Face-to-Face |
| 11 | Hilbert spaces and Fourier series: Orthonormal series, applications to Fourier series, orthonormalization method, polynomial applications | Face-to-Face |
| 12 | Eigenvalue problems for linear, compact, symmetric operators; Hilbert-Schmidt theorem and applications | Face-to-Face |
| 13 | Self-adjoint operators, energy spaces, Friedrichs expansions, Poincaré inequality | Face-to-Face |
| 14 | Applications of self-adjoint operators: Semigroups, one-parameter groups in physics, generalized eigenfunctions, trace operators | Face-to-Face |

**Assessment and Evaluation:**

| **Method** | **Quantity** | **Weight** |
| --- | --- | --- |
| **Midterm Exam** | 1 | 50% |
| **Quizzes** | None | - |
| **Assignments** | Pre- and post-midterm activities | - |
| **Projects** | None | - |
| **Final Exam** | 1 | 50% |

**Learning Outcomes:**

1. Learn Hilbert spaces, bilinear forms, and variational problems.
2. Apply the Banach fixed-point theorem and iteration methods to integral equations.
3. Understand linear functionals, the Riesz theorem, and nonlinear monotone operators.
4. Apply orthonormal series and Fourier series.
5. Apply Brouwer and Schauder fixed-point theorems to integral equations.

**Special Notes:**

* **UE:** Remote Education
* **YY:** Face-to-Face Education